CNTT-E-142

# BASIC ELECTRICITY AND ELECTRONICS

# STUDENT HANDOUT

# NO. 305

# SUMMARY PROGRESS CHECK AND JOB PROGRAM FOR MODULE 31-2

JUNE 1984

SUMMARY
LESSON 2

RF Amplifiers

Amplifiers are called RF amplifiers only because they have untuned or tuned input and output coupling with a frequency response in the RF range. Tuned coupling is more common because we are usually interested in the RF amplifier's selectivity when we tune to a specific station on a radio receiver.

Transformers can be made into tuned parallel resonant coupling circuits by placing a capacitor across either or both windings. An example using tuned coupling transformers in a basic amplifier circuit is shown in Figure 1.

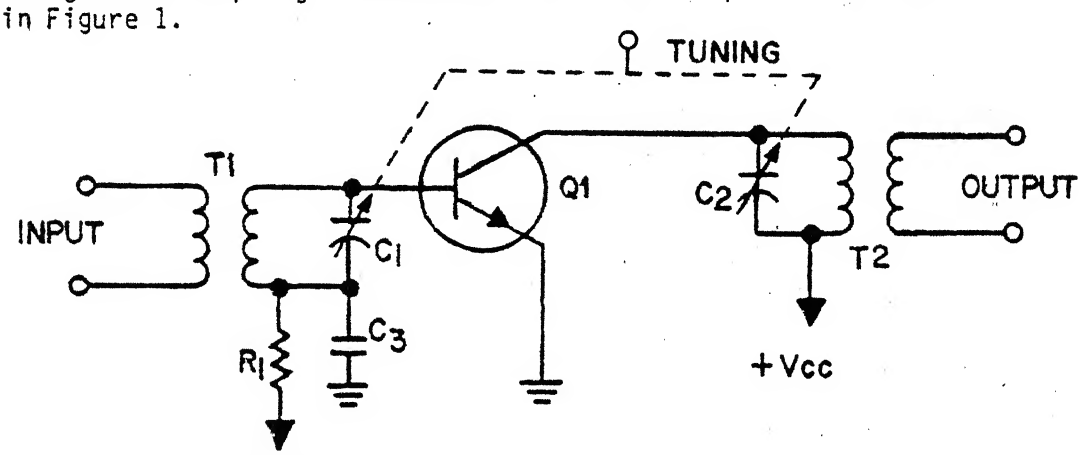



Figure 1

TUNED RF AMPLIFIER

If all the resonant circuits are tuned to the same frequency, the signal input to Q1 and signal output from T2 will be maximum at that Fo.

Amplifier selectivity is directly related to the number of circuits tuned to the same frequency in the amplifier's signal path. This relationship is shown in Figure 2.

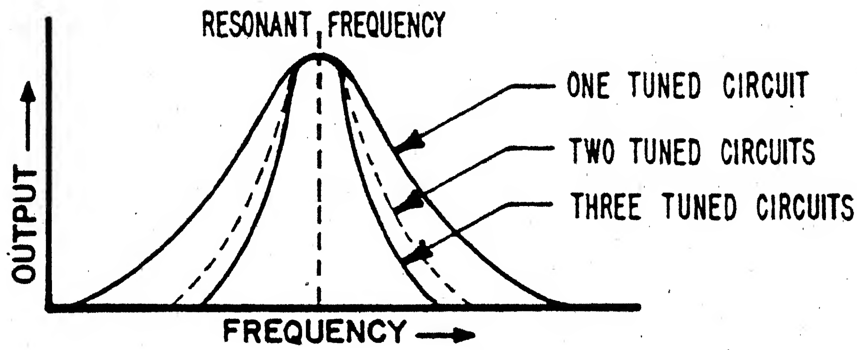



Figure 2

RF AMPLIFIER FREQUENCY RESPONSE CURVES

The input and output coupling tanks can be variable tuned at the same time if the capacitors or inductors are connected together, or "ganged". Figure 3 shows a circuit with ganged variable capacitors.

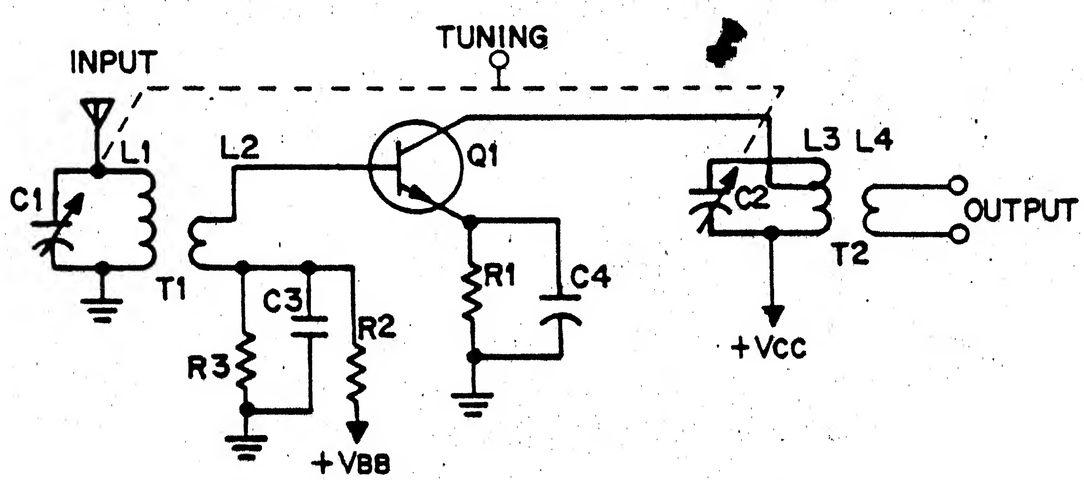
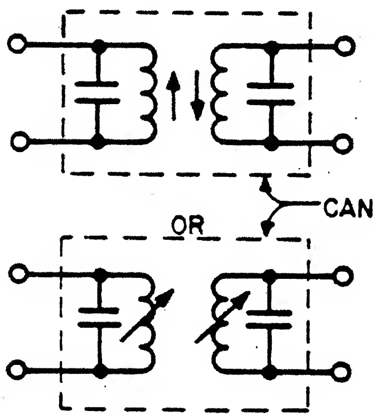



Figure 3

GANGED CAPACITIVE TUNING

Capacitors may be ganged by gears, pulleys, and most often by a common shaft.

Figure 4 shows schematics and a pictorial view of an individual inductive tuned RF transformer.



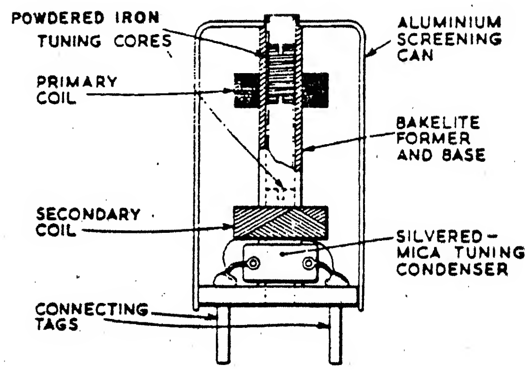




Figure 4

INDUCTIVE TUNED RF TRANSFORMER

The primary and secondary windings can be independently tuned. The entire unit is completely enclosed within a metallic shield. This device is very common in radio receivers and transmitters.

Transformer coupling is inefficient for higher RF signals. To get around this problem, the modified coupling circuit in Figure 5 retains the selectivity advantages of the parallel resonant circuit. C3 provides additional coupling between L1 and L2.

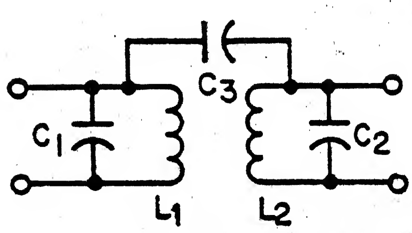



Figure 5

CAPACITIVE COUPLED TUNED TANKS

The Q of an inductor, tank, or loaded circuit expresses the relationships between inductive reactance (XL), capacitive reactance (XC), and resistance (R). The Value Q, or quality, represents the ratio of "energy stored/energy used". Figure 6 shows the inductor equivalent for XL and Rc (coil resistance).

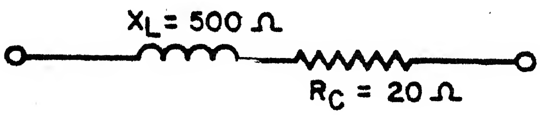



Figure 6

INDUCTOR EQUIVALENT

The formula for Q of a coil is Qcoil = XL divided by Rc, or 25 in the example. Figure 7 shows a simple LC tank circuit.

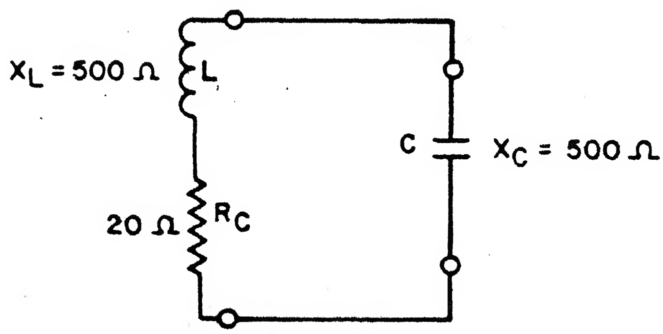



Figure 7

TANK CIRCUIT

In the tank, both XL and XC are equivalent expressions for energy stored. Therefore, the formula for Q of the tank is Qtank = XL (or XC) divided by Rc, or 25 in the example.

Bandwidth can be determined by the formula BW = Fo divided by Q tank. The relationship between the Q of a tank and bandwidth can be seen in the tank circuit diagram and tank frequency response curve in Figure 8.

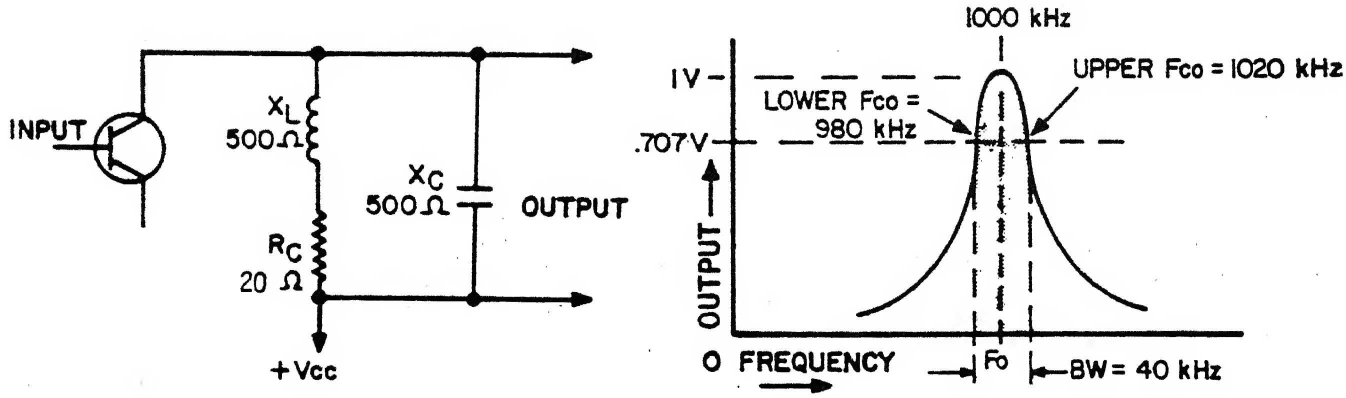



Figure 8

TANK Q vs BANDWIDTH

The figure shows a 40 kHz bandwidth. You can calculate the bandwidth by plugging the circuit diagram values into the formula for Q and bandwidth. In the example, Q equals 25, and bandwidth equals 1000 kHz divided by Q, or 40 kHz. The steep sides, or skirts, on the frequency response curve indicate that the Q of the tank produces high selectivity. If the coil resistance in the tank increases while XL, XC, and Fo remain constant, the Q would lower and the bandwidth would widen. Coil resistance can be increased by winding coils of the same XL with smaller diameter wire.

Figure 9 shows a loaded circuit which includes a tank, switch, and parallel load (Rp).

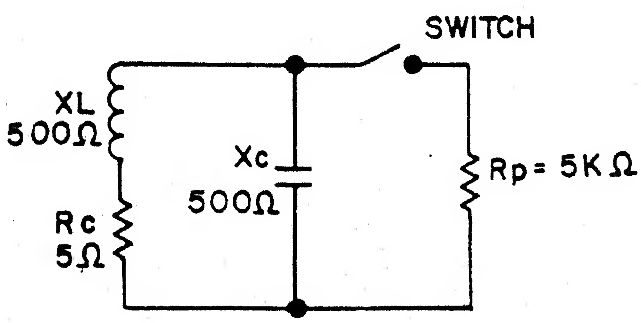



Figure 9

LOADED CIRCUIT

When the switch is open, the Q of the unloaded tank is expressed by the familiar ratio XL (or XC) divided by Rc, or 100 in the example. When the switch is closed, the Q of the loaded tank circuit is Q ckt = Rp divided by XL (or XC), or 10 in the example. The Q of the circuit will be lower when a load is placed on a tank than the Q of the tank without a load. In wideband RF amplifiers, "swamping" resistors sometimes are placed across tank circuits to purposely lower the Q of the circuit and widen the bandwidth.

Figure 10 shows a typical RF amplifier input stage in a broadcast band radio receiver.

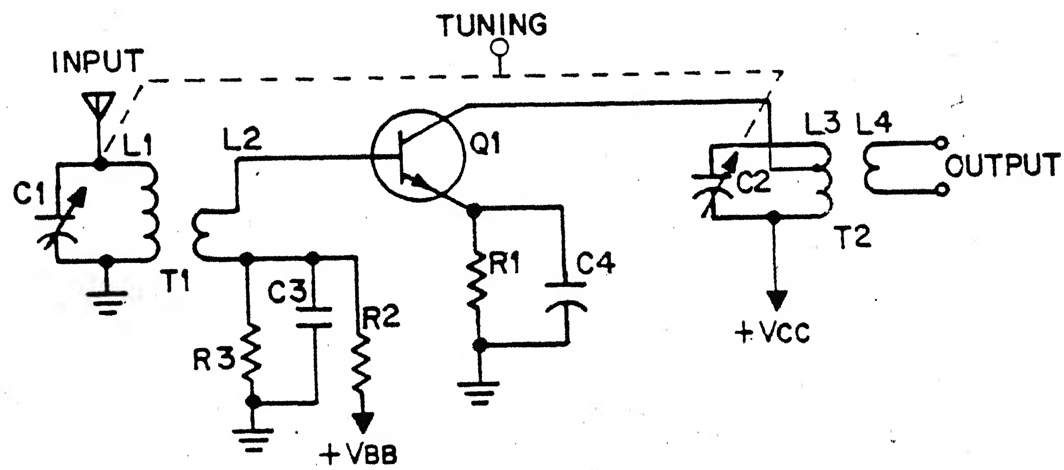



Figure 10

TYPICAL TUNED RF AMPLIFIER

R2 and R3 form a voltage divider to provide forward bias for Q1. C3 places the bottom of L2 at RF ground potential and ensures all signal development is across L2. T1 is a step-down transformer with the low impedance winding L2 connected to the base of Q1. This impedance match provides for maximum energy transfer between the antenna and base of Q1, and also preserves the Q of the L1-C1 tank.

Both the Q and selectivity of tank L3-C2 are preserved in a similar manner. The technique of tapping L3 provides a good impedance match between the collector of Q1 and tank L3-C2. Therefore maximum energy transfer occurs between the output of Q1 and the input to the following stage. Note that $V_{BB}$ and $V_{CC}$ are often one and the same source.

In Figure 10, tank L1-C1 selects one of the many frequencies received by the antenna. The signal then is coupled to L2, fed into the base of Q1, amplified, and coupled by T2 to the next stage.

Figure 11 shows one of the many different ways the amplifier circuit in Figure 10 can be drawn.

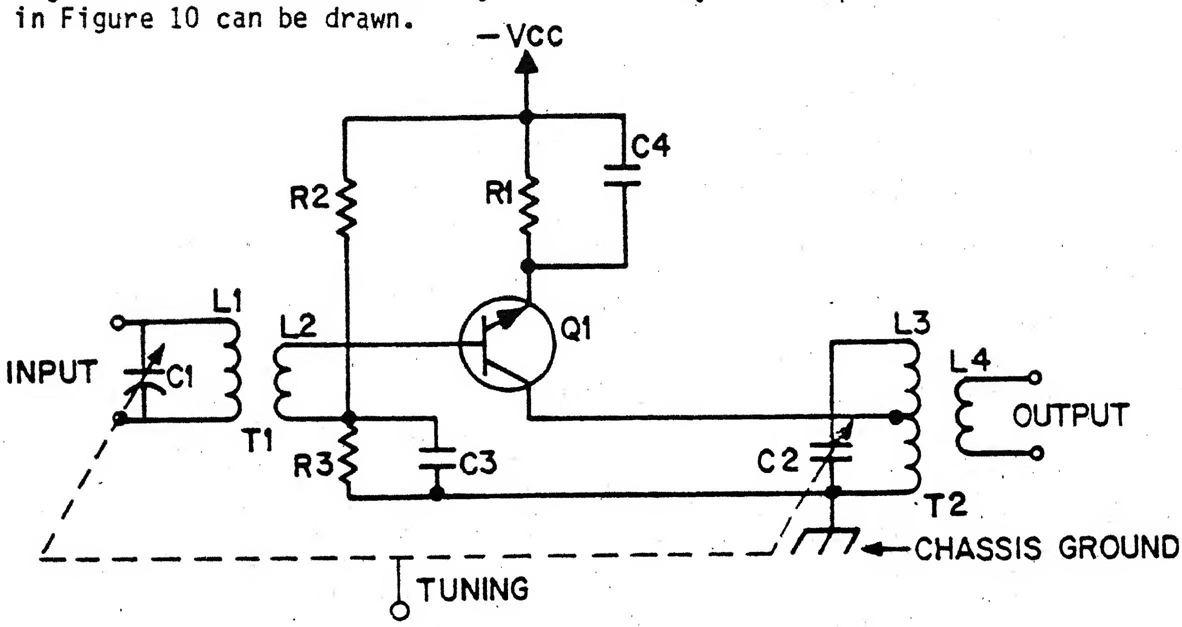



Figure 11

TUNED RF AMPLIFIER

One minor difference is that the tank L3-C2 in Figure 11 is grounded on one side allowing easy attachment of the capacitor frame to the chassis.

Transistors in tuned RF amplifiers have an internal regenerative feedback circuit which may cause oscillation at the higher frequencies. This internal regenerative feedback path is shown in the shaded area of Figure 12.

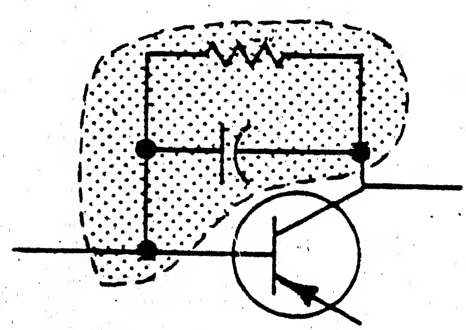


Figure 12

TRANSISTOR INTERNAL FEEDBACK

We can neutralize this internal feedback, and prevent oscillation, by connecting an external feedback circuit which produces a voltage equal in amplitude and opposite in polarity to the internal feedback voltage. Figure 13 shows two types of amplifier neutralization circuits, each labeled Cn.

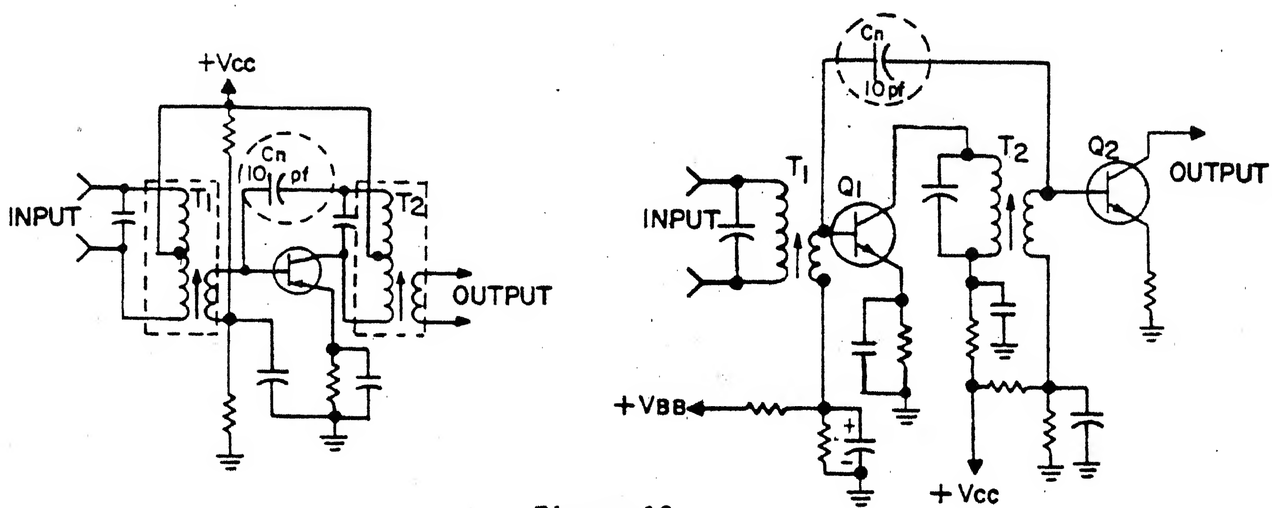



Figure 13

TYPICAL NEUTRALIZING CIRCUITS

RF amplifiers are designed to take into consideration any "stray reactances" at high frequencies caused by the position of wires and components in relation to the chassis. The capacitances Co and Cin in Figure 14 are examples of stray reactances.

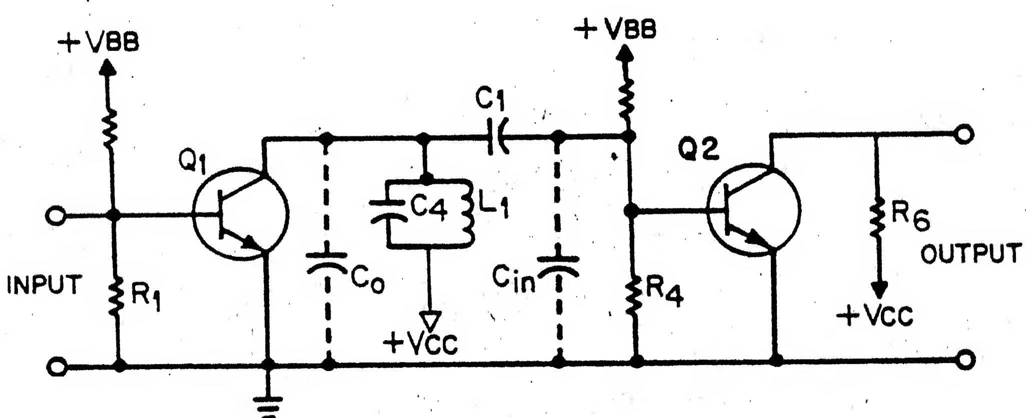



Figure 14

STRAY REACTANCES IN RF AMPLIFIER CIRCUIT

You must be neat and cautious when you repair a circuit so that replaced components will be positioned as they were before repair. Otherwise you may cause a frequency change or oscillation in the amplifier.

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Amplifiers can be biased to operate either Class A, B, AB, or C. Figure 15 shows the signal input, transistor conduction waveform and time, and signal output for one cycle in Class A and Class B amplifiers (CE) with resistive loads.

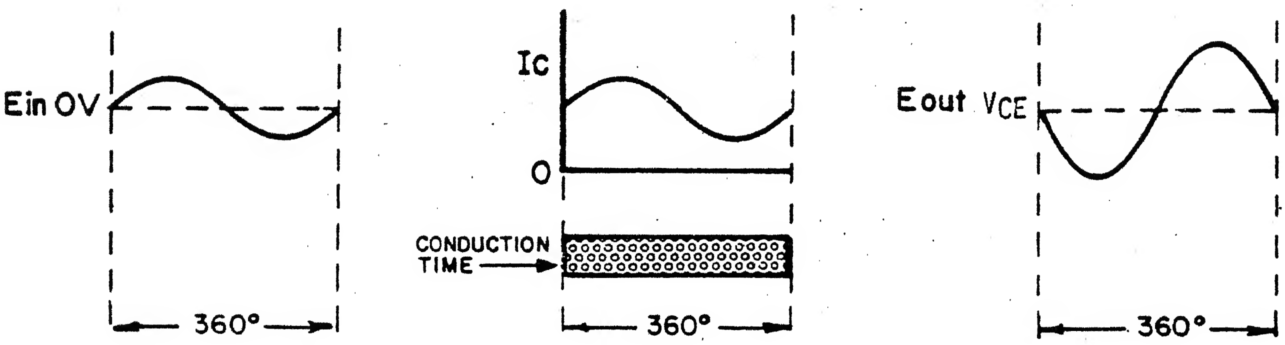



Figure 15

CLASS A OPERATION

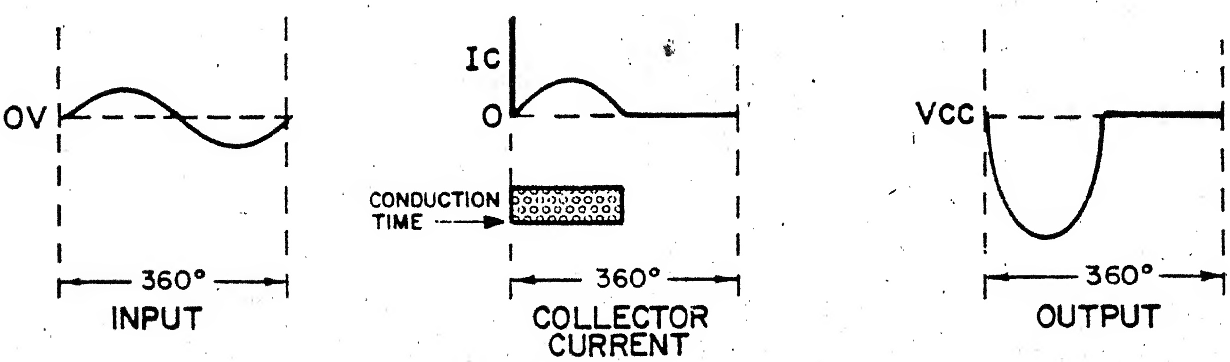



Figure 15

CLASS B OPERATION

In Class A amplifiers, the forward bias is set high enough so that the transistor conducts over the entire input cycle. In Class B amplifiers, the bias is set near zero which causes the transistor to conduct for about half the input cycle. This produces a clipped, or distorted, output signal. The reduced conduction time makes Class B amplifiers more efficient than Class A amplifiers.

Figure 16 shows the operation for Class AB and Class C amplifiers with resistive loads.

In Class AB amplifiers, the bias is set to cause the transistor to conduct for between 180° and 360° of the input cycle. Class AB amplifiers have less output distortion, but lower efficiency, than Class B amplifiers.

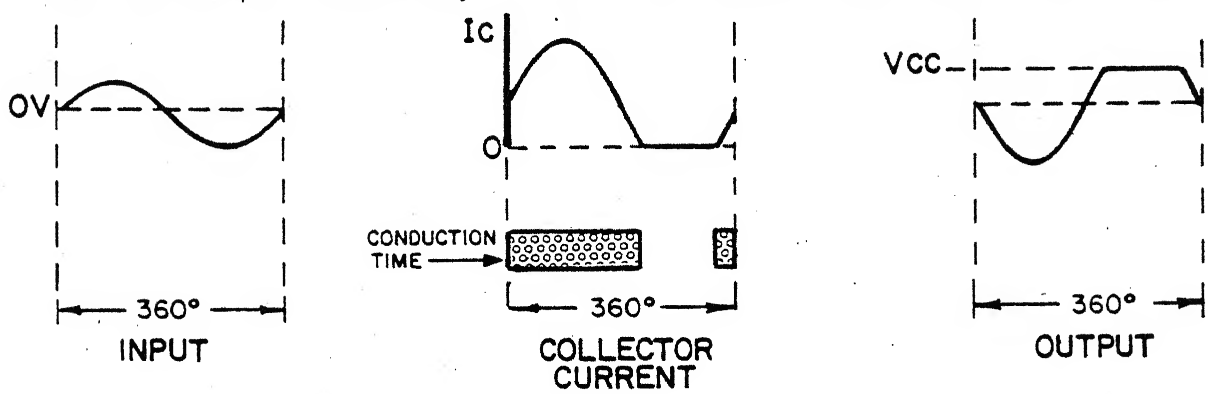



Figure 16

CLASS AB OPERATION

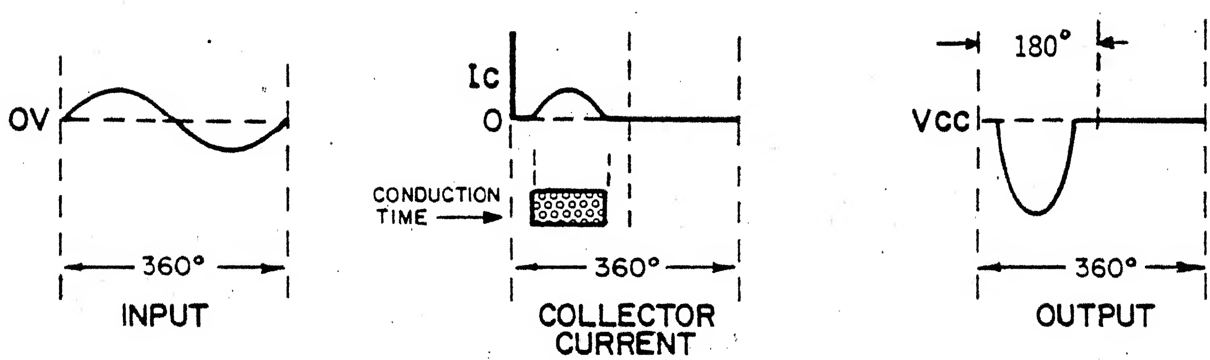



Figure 16

CLASS C OPERATIONS

In Class C amplifiers, the reverse bias causes the transistor to conduct for about 120° of the input cycle.

Class C amplifiers have the greatest output signal distortion, but the greatest efficiency of the four operating classes. Figure 17 shows an application of a Class C amplifier circuit.

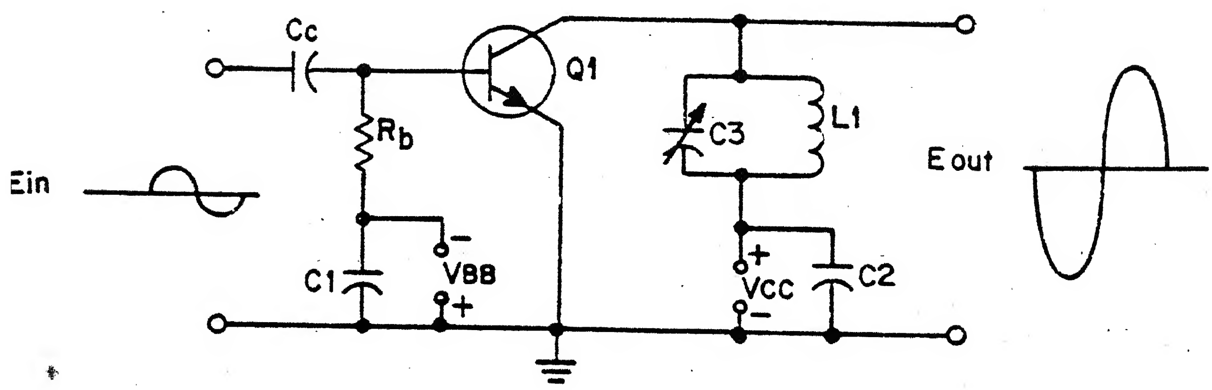



Figure 17

CLASS C RF AMPLIFIER

The actual output wave in Figure 17 is not the expected clipped wave which is characteristic of Class C RF amplifier circuits. The flywheel effect of the tank produces a damped sine wave output signal for each current pulse from the transistor. In Class C RF amplifier circuits, the tank receives the current pulse as shown in Figure 18.

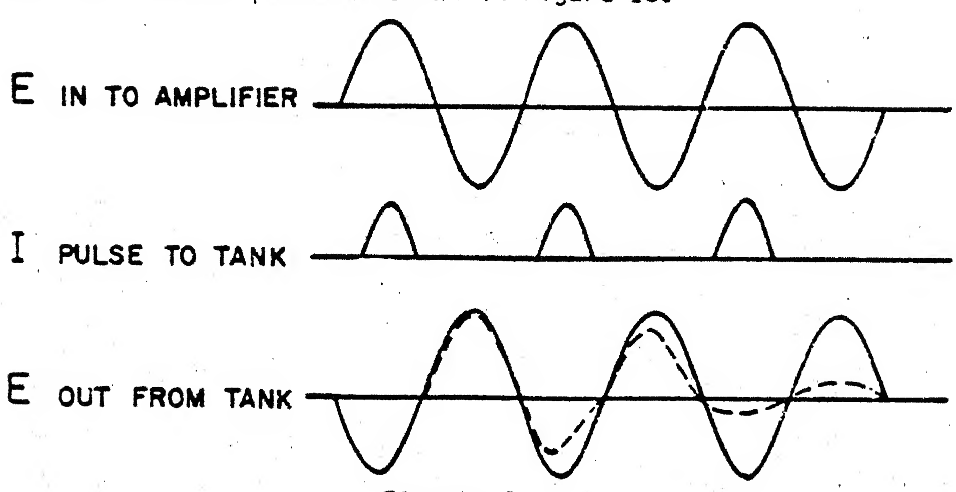



Figure 18

TANK OUTPUT FROM CLASS C AMPLIFIER OPERATION

The repeated current pulses change the damped output wave (shown by the dotted line) to resemble the reasonably good sine-wave (shown by the solid line). The flywheel effect is often used in Class AB, B, and C RF/IF amplifiers to provide a non-distorted sine wave output.

Amplifier efficiency is inversely related to the amount of operating power, and therefore, the amount of operating current. Class C amplifiers are the most efficient, and are used in applications which require large amounts of output power such as the final output amplifier of a radio transmitter.

One method to test an amplifier's frequency response is to inject each frequency value from a standard signal generator into an amplifier, and then graph each output signal as displayed on an oscilloscope. A more efficient and accurate test method is to use a sweep frequency generator as input to the amplifier, and then directly observe the frequency response curve output on the oscilloscope. The sweep frequency generator produces a variable FM signal that sweeps back and forth over a section of the frequency spectrum.

Figure 19 shows a typical sweep frequency generator/oscilloscope set-up.

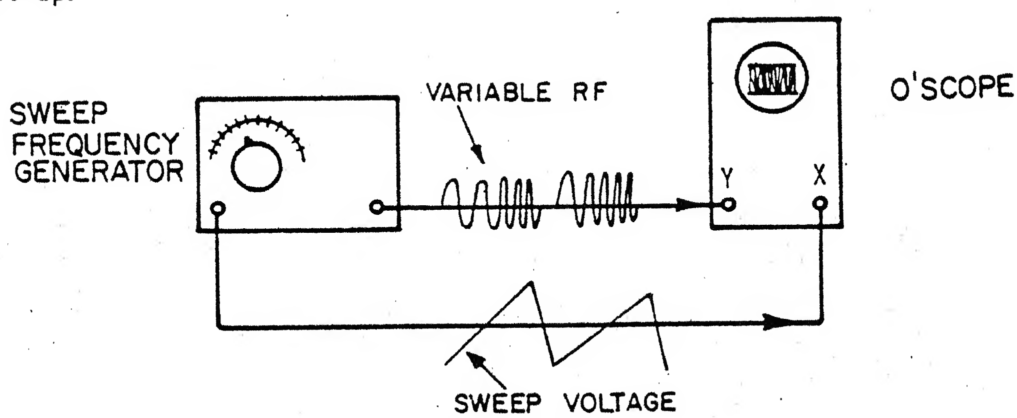



Figure 19

FREQUENCY SWEEP

The variable frequency signals from the generator are fed to the vertical input (Y) terminal of the oscilloscope. The CRT produces a rectangular display which is a combination of the sine waves from the input frequencies, and is often called a "frequency sweep". The generator also produces a horizontal sweep sawtooth wave output that is synchronized with the variable frequency output signal. The horizontal sweep output is connected to the X terminal of the oscilloscope. Since the oscilloscope inputs are synchronized, the CRT display is based on frequency and not on time.

A typical CRT display is shown in Figure 20.

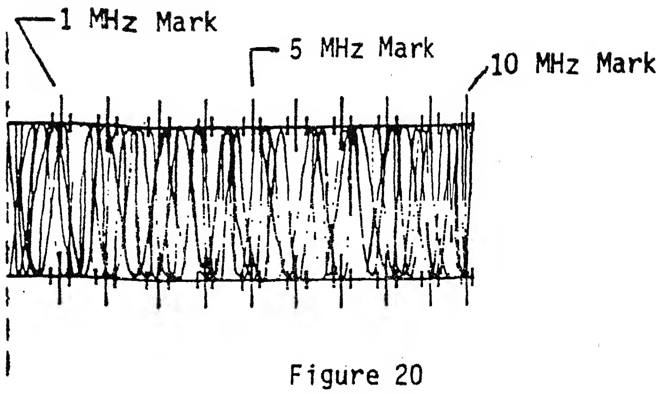



Figure 20

FREQUENCY SWEEP WITH MARKERS

In the figure, the frequency marker pips show a sweep of 5 MHz on either side of an Fo of 5 MHz.

Figure 21 shows a typical sweep frequency generator test set-up.

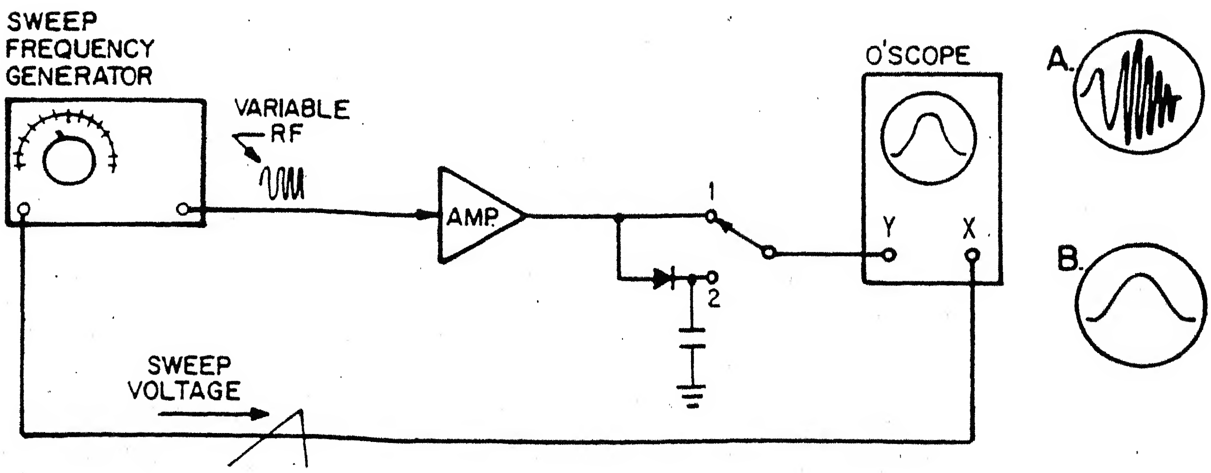



Figure 21

SWEEP FREQUENCY GENERATOR METHOD

In switch position #1, the CRT displays insert A. In switch position #2, the rectifier-filter demodulator converts the CRT display to the frequency response curve in insert B.

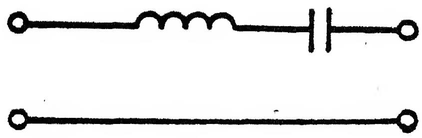
You will have the opportunity to use the sweep frequency generator in the job program for this lesson. With this device, you will measure the frequency response of an RF amplifier in the NIDA trainer.

AT THIS POINT, YOU MAY TAKE THE LESSON PROGRESS CHECK. IF YOU ANSWER ALL SELF-TEST ITEMS CORRECTLY, YOU MAY TAKE THE JOB PROGRAM. IF YOU INCORRECTLY ANSWER ONLY A FEW OF THE PROGRESS CHECK QUESTIONS, THE CORRECT ANSWER PAGE WILL REFER YOU TO THE APPROPRIATE PAGES, PARAGRAPHS, OR FRAMES SO THAT YOU CAN RESTUDY THE PARTS OF THIS LESSON YOU ARE HAVING DIFFICULTY WITH. IF YOU FEEL THAT YOU HAVE FAILED TO UNDERSTAND ALL OR MOST OF THE LESSON, SELECT AND USE ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS (IF APPLICABLE), OR CONSULT WITH THE LEARNING CENTER INSTRUCTOR, UNTIL YOU CAN ANSWER ALL SELF-TEST ITEMS ON THE PROGRESS CHECK CORRECTLY.

PROGRESS CHECK
LESSON 2

RF Amplifiers

1. From the diagrams below, select the two parallel resonant coupling circuits.

A.


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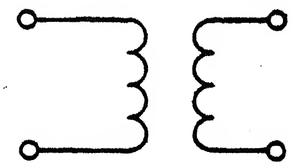

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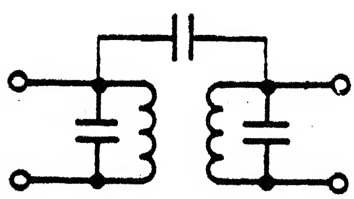

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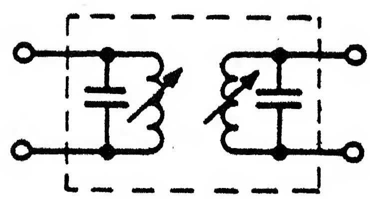
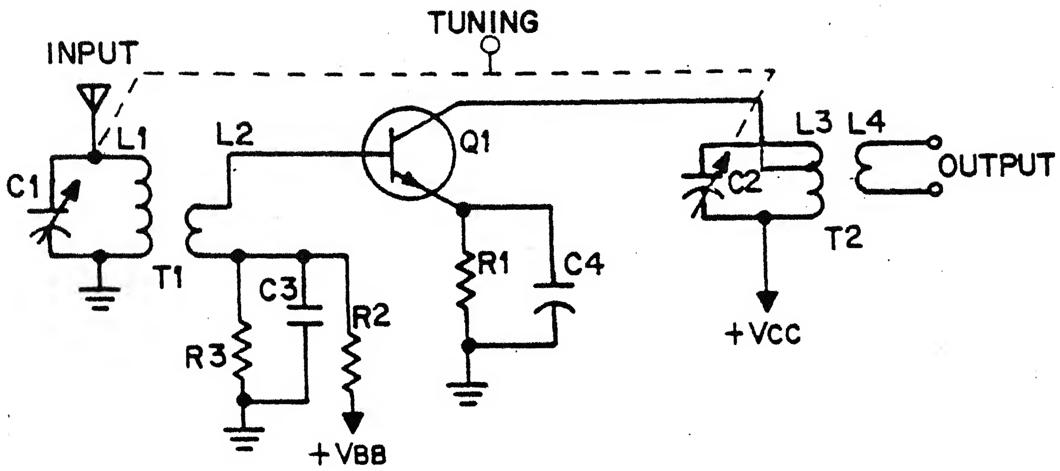


a. A, B
b. B, C
c. C, D
d. D, B

USE THE DIAGRAM BELOW TO ANSWER QUESTIONS 2 AND 3.




2. In this amplifier, tuning is done in the

   a. amplifier input section only.
   b. amplifier output section only.
   c. conversion section only.
   d. amplifier input and output sections.

3. This amplifier has ______________ tuning.

   a. single inductive
   b. single capacitive
   c. ganged inductive
   d. ganged capacitive

4. The Q of tank A is 10, and the Q of tank B is 20. Both tanks have the same Fo. Tank A has a ____________ bandwidth and ______________ selectivity than tank B.

   a. narrower, less
   b. narrower, greater
   c. wider, less
   d. wider, greater

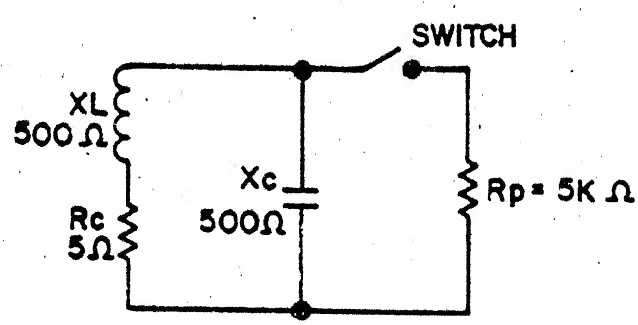
5. Both coil A and coil B have the same XL. Coil A is wound with smaller diameter wire than coil B. The Q of coil A is

   a. higher than the Q of coil B
   b. lower than the Q of coil B
   c. the same as the Q of coil B

6. Swamping resistors are placed across tank circuits in order to

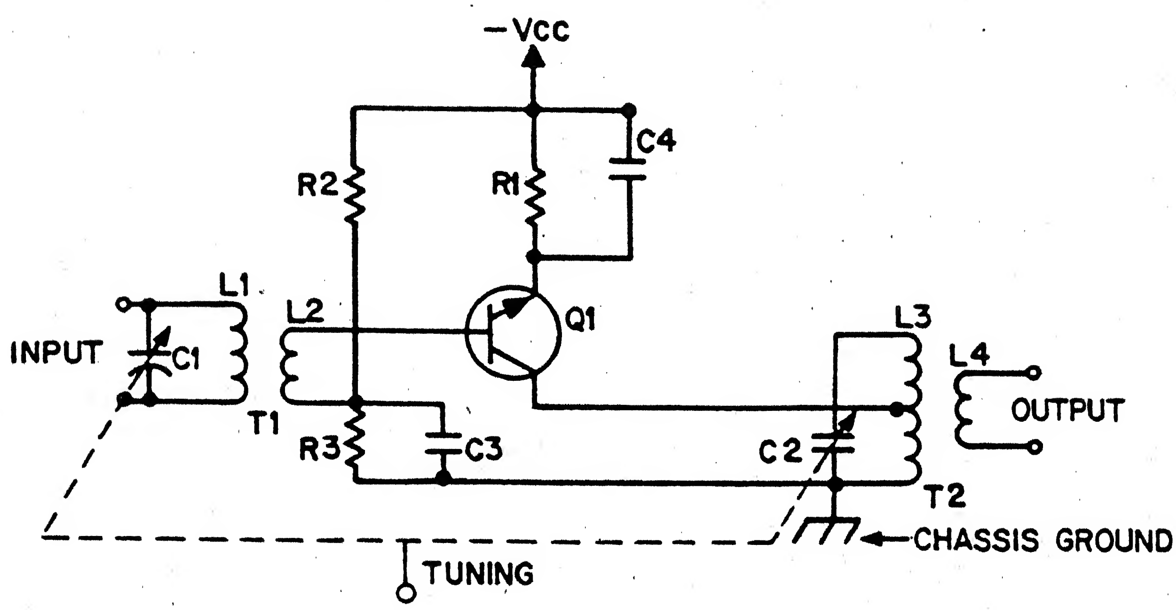
   a. increase the selectivity of the amplifier
   b. increase the Q of the tank
   c. increase the gain of the amplifier
   d. widen the bandwidth of the tank

USE THE DIAGRAM BELOW TO ANSWER QUESTION 7.




7. The Q of the resonant circuit with the switch closed has a value of ____________________.

USE THE DIAGRAM BELOW OF AN RF AMPLIFIER CIRCUIT TO ANSWER QUESTION 8.




8. An impedance match between Q1 and the output coupling network is performed by which component?

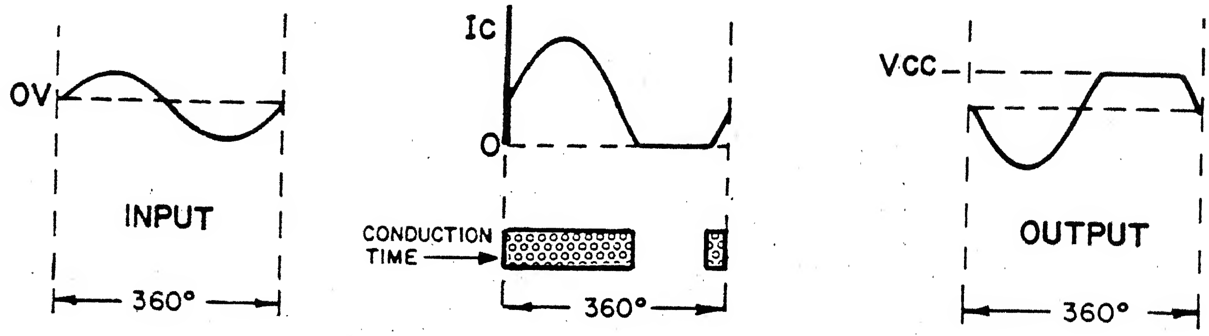
   a. C2
   b. L3
   c. L4
   d. Vcc

9. The purpose of neutralization components in RF amplifiers is to prevent

   a. stray reactances
   b. oscillation
   c. internal feedback
   d. external feedback

10. The transistor conducts for half the signal input cycle in Class ___ amplifiers.

USE THE DIAGRAM BELOW TO ANSWER QUESTION 11.




11. The diagram shows the output signal waveform for Class ________ amplifiers.

12. The least efficient amplifier class of operation is Class ________.

13. Non-distorted sine wave outputs in Class AB, B, and C amplifiers are provided by:

    a. increasing the pulse rate through the transistors
    b. matching impedance between transistor inputs and outputs
    c. adding RC components to transistor outputs
    d. using tuned tanks in transistor amplifiers

14. The oscilloscope CRT display from a sweep frequency generator is based on:

    a. a single frequency
    b. variable amplitudes
    c. variable frequencies
    d. variable time

15. In order to directly observe the frequency response curve for a test amplifier, the amplifier input comes from a:

    a. sweep frequency generator
    b. standard RF signal generator
    c. standard oscilloscope
    d. VOM

CHECK YOUR RESPONSES TO THIS PROGRESS CHECK WITH THE ANSWER SHEET. IF YOU ANSWER ALL SELF-TEST ITEMS CORRECTLY, PROCEED TO THE JOB PROGRAM. IF YOU INCORRECTLY ANSWER ONLY A FEW OF THE PROGRESS CHECK QUESTIONS, OR IF YOU FEEL YOU HAVE FAILED TO UNDERSTAND ALL OR MOST OF THE LESSON, SELECT AND USE ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS (IF APPLICABLE), OR CONSULT WITH THE LEARNING CENTER INSTRUCTOR, UNTIL YOU CAN ANSWER ALL SELF-TEST ITEMS ON THE PROGRESS CHECK CORRECTLY.

INFORMATION SHEET
LESSON 2

## Telonic 1232A Sweep Generator

The sweep generator is a versatile piece of test equipment that can be used to align receivers or to check bandwidth and frequency response of electronic circuits.

The sweep generator is a type of signal generator. When the signal generators you used previously were set to a frequency, they produced only that frequency. A sweep generator produces a signal that varies (sweeps) from a frequency below the center frequency to a frequency above the center frequency. This is usually stated as the center frequency plus or minus some number of Hertz; for example, 10.7 MHz ± 75 kHz. This means that the sweep frequency generator is capable of producing an output signal from 75 kHz below 10.7 MHz (10.625 MHz) to 75 kHz above 10.7 MHz (10.775 MHz). These frequencies therefore could be used for alignment of IF amplifiers in commercial FM receivers.

The sweep generator produces an output which has a flat response curve across a very broad band of frequencies. That is, the signal amplitude stays the same throughout its sweep range.

When used with an oscilloscope, the output of the sweep generator is visually displayed for alignment or bandwidth and frequency response measurement of the device under test.

Markers are added to the display to aid in determining center frequency, bandwidth, and frequency response.

Markers are signals injected by the sweep generator to provide a reference for signal location.

The sweep generator produces a horizontal reference voltage which when applied to the horizontal input of the oscilloscope, is equal to the amount of variation above and below the center frequency.

The signal as applied to the vertical input will give an indication as to the gain of the unit under test with reference markers superimposed.

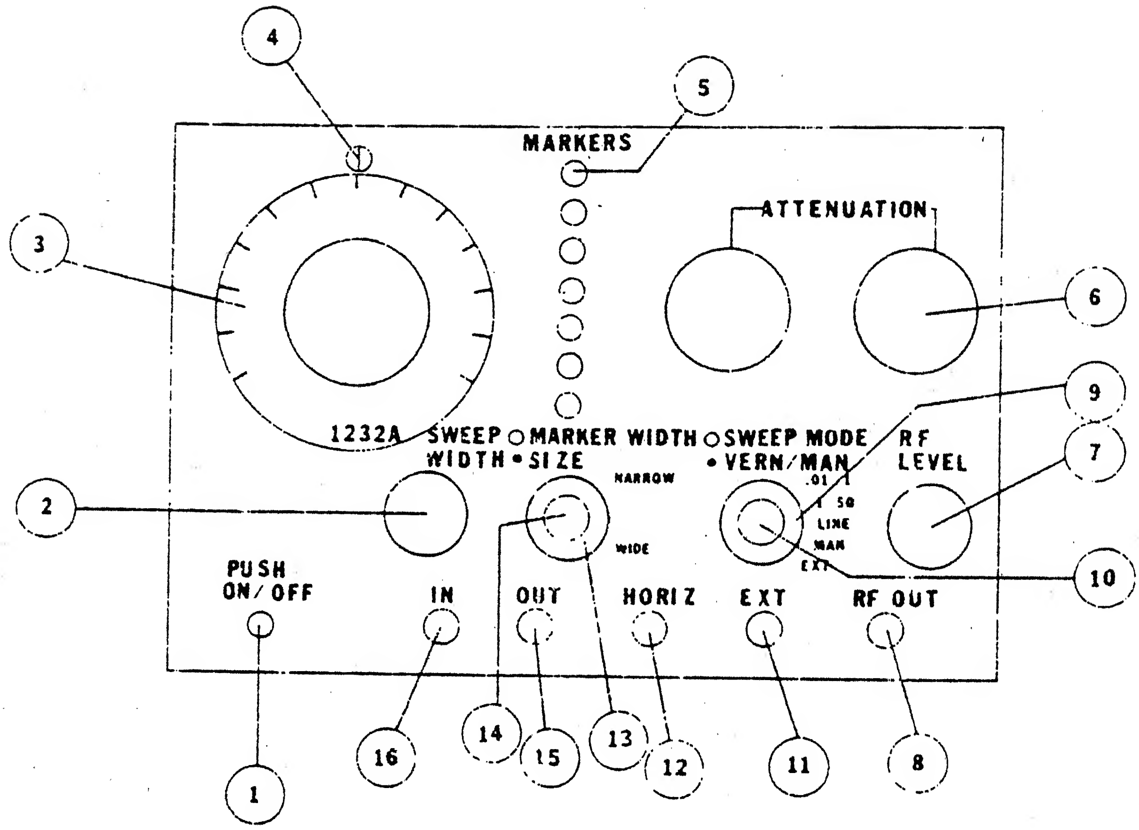



Figure 1

MODEL 1232A FRONT PANEL CONTROLS AND CONNECTORS

FUNCTION OF CONTROLS, SWITCHES AND CONNECTORS

Refer to Figure 1 for the below listed controls and connectors.

1. POWER SWITCH (1) provides on/off control of AC power.

2. SWEEP WIDTH (2) provides continuous variation in sweep width from 100 kHz to 120 MHz. The variation is above and below the center frequency.

3. CENTER FREQUENCY DIAL (3) determines the center frequency of the swept RF output.

4. POWER INDICATOR AND DIAL POINTER (4) illuminates when instrument is turned on.

5. MARKERS ON/OFF (5) provides on/off control of individual markers.

6. ATTENUATORS (6) provides coarse and fine attenuation of the RF output.

7. RF LEVEL (7) provides 3 dB of RF output level variation. This will give you the 70.7% of the output signal to determine the half-power points.

8. RF OUT (8) type BNC connector provides swept RF output.

9. SWEEP MODE (9) selects various sweep rates and modes.

10. VERN/MAN (10) varies the sweep rate of the output signal.

11. EXT INPUT (11) type BNC connector provides an input for external control of sweep.

12. HORIZ OUTPUT (12) type BNC connector provides a sweep voltage (horizontal reference voltage) to the horizontal input of an oscilloscope.

13. MARKER WIDTH (13) selects between two marker widths

14. MARKER SIZE (14) varies the amplitude of the markers.

15. MARKER ADDER OUT (15) type BNC connector provides detected response with markers superimposed to vertical input of an oscilloscope.

16. MARKER ADDER IN (16) type BNC connector. Provides an input for the detected response for superimposing the markers

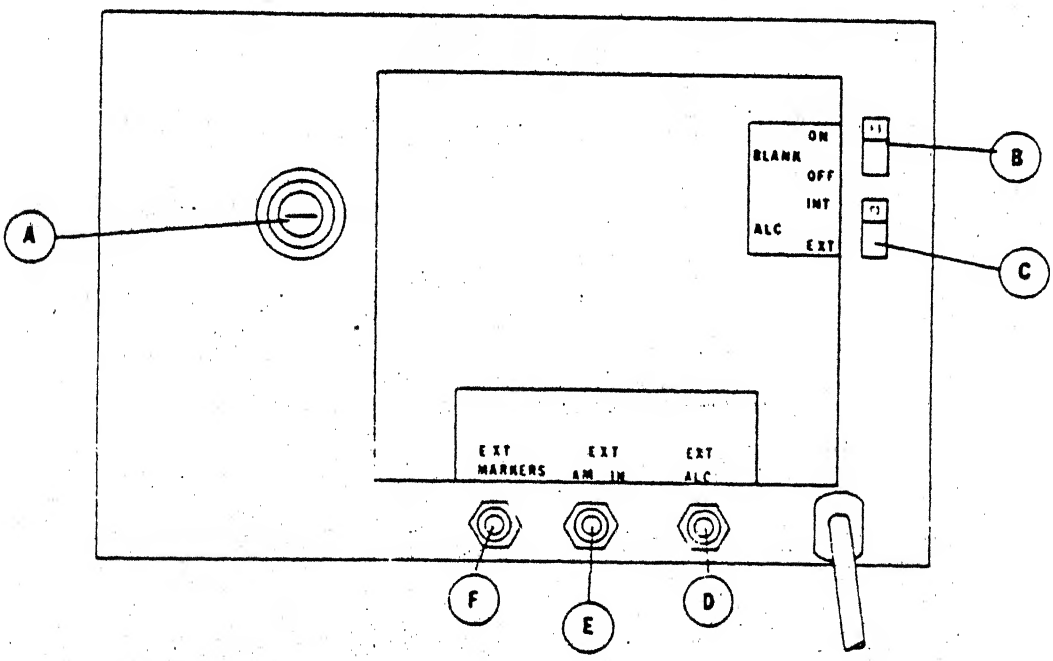



Figure 2

MODEL 1232A REAR PANEL CONTROLS AND CONNECTORS

Refer to Figure 2 for the below listed controls and connectors.

1. Fuseholder (A) contains power line fuse (1 amp).

2. BLANKING ON/OFF (B) switch retrace blanking "on" or "off." (permits showing or eliminating sweep returning to start of trace).

3. ALC INT/EXT (C) Selects between the internal monitor or an external monitor. (ALC or automatic level control, keeps the RF output at a constant level)

4. EXT ALC INPUT (D) type BNC connector provides input for an external monitor. The monitor is an RF detector used to sample the output.

5. AM INPUT (E) type BNC connector provides input for AM modulation of the RF output. (will not be used at this time)

6. EXT MARKER INPUT (F) type BNC connector. Provides an input at 50 $\Omega$ (ohms) from an external source which is used to generate a marker at the source frequency.

# JOB PROGRAM
# FOR
# LESSON II

## Sweep Generators and RF Amplifiers

### INTRODUCTION

This Job Program is designed to familiarize you with the operation of the Telonic Model 1232A Sweep Generator and the uses to which it can be applied in the alignment of receivers and in checking bandwidth and frequency response in electronic circuits. All voltages and resistances measured should be within +/- 20% tolerance with those given on the answer sheet to the job program.

### SAFETY PRECAUTIONS:

Observe all standard safety precautions. Beware of all exposed connections. An energized circuit may have dangerous voltages present.

### EQUIPMENT REQUIRED

1. Telonic 1232A Sweep Generator
2. Dual Trace Oscilloscope-NIDA 207 or equivalent
3. RF Detector B & K Model PR-32
4. NIDA 205 Transceiver Trainer
5. BNC-BNC Cables (2)

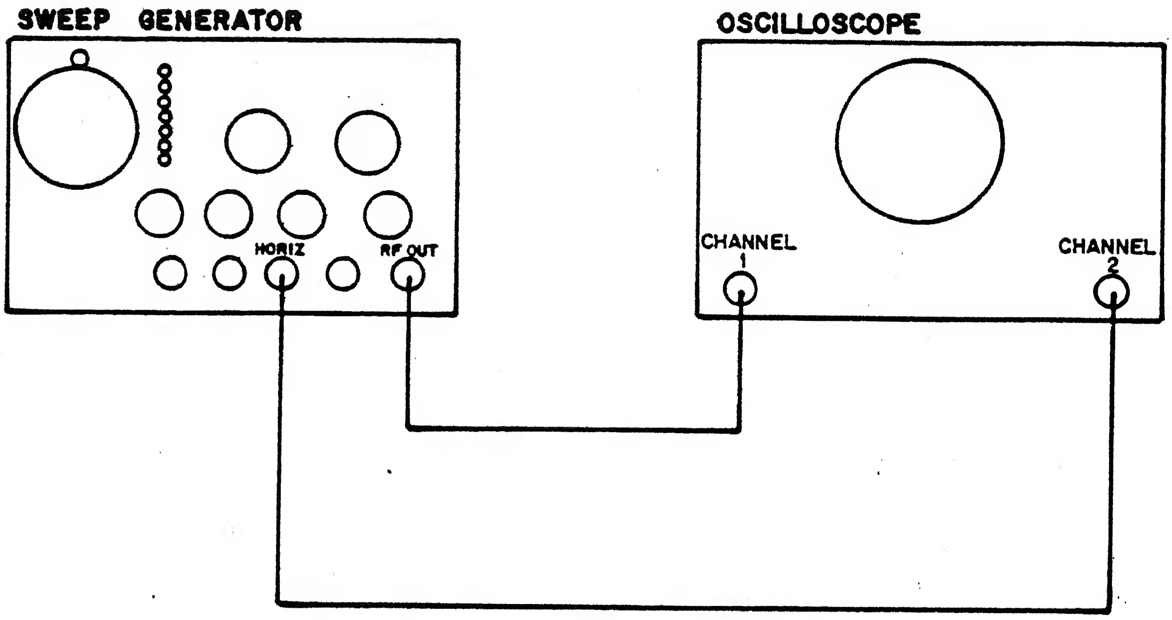

SWEEP GENERATOR
OSCILLOSCOPE
HORIZ
RF OUT
CHANNEL 1
CHANNEL 2

Figure 1

PROCEDURES:

1. Connect the Sweep Generator as shown in Figure 1.

2. Set the controls on the Sweep Generator as follows:

   a. Sweep width control fully CCW.

   b. Sweep mode control to "EXT/CW".

   c. VERN/MAN control to mid-range.

   d. RF level control to mid-range.

   e. Attenuation controls to "0".

   f. Center frequency dial to "0".

   g. Blanking on/off to "ON" (Back of Sweep Generator).

   h. Turn all marker switches to "off" position.

3. Set the oscilloscope to the X-Y mode (all display mode switches out).

   a. Set the channel 1 Volts/Div control to "2".

   b. Set the channel 2 Volts/Div control to "2".

   c. Set the CH-1 and CH-2 TRIG MODE switches to the "out" position.

   d. Set triggering source switch to "EXT".

4. Turn on the sweep generator and the oscilloscope. Allow sufficient time for the equipment to warm up.

5. You should see a vertical line on the oscilloscope. Using the chan 2 horizontal position control, center the line on the scope. Manipulate the following controls on the oscilloscope so you can see that they have no effect on the presentation.

   a. Time/Div controls.

   b. Triggering controls (Stability control on some scopes may affect display).

   c. Horizontal position control.

   d. The stability control must still be used to obtain a sweep.

NOTE: Now you can see that the sweep generator controls the presentation on the scope. There is an RF output from the sweep generator, but no horizontal output at this time, indicating there is no sweep voltage being applied to the horizontal deflection plates of the oscilloscope.

6. To prove that there is a frequency from the sweep generator, remove the BNC connector from the channel 1 input to the scope.

   a. What happened to the vertical line?__________________.

   b. Reconnect the BNC connector to channel 1 of the scope.

7. Set the sweep mode switch on the sweep generator to the ".01-1" position. Notice that the trace on the scope starts to sweep from a frequency below to a frequency above the frequency observed in step 5, indicating that there is a sweep voltage from the sweep generator horizontal output jack.

8. To prove this, remove the BNC connector from the channel 2 input to the oscilloscope.

   a. What happened to the sweep voltage?__________________.

   b. Reconnect the BNC connector to channel 2 of the scope.

9. Set the sweep mode control to the "1-50" position. Notice that the sweep speed increased.

10. Turn the sweep width control to mid-range. You should notice an increase in amplitude over a small range of the presentation.

11. Turn the center frequency dial until the center of this change in amplitude is exactly in the center of the scope.

12. Turn the sweep width control until the left and right side of the display drops to near zero.

    a. What happened to the <u>amount</u> of frequencies being swept by the sweep generator?_______________.

13. Set the sweep mode control to the ".01-1" position. Notice that the waveform, if plotted, is exactly the same as the waveform in step 12.

14. Set the VERN/MAN control fully CCW.

15. Turn the VERN/MAN control slightly CW. Notice that the center frequency starts to sweep.

16. Turn the VERN/MAN control to mid-range.

    a. What happened to the <u>rate</u> (speed) at which the frequencies are being swept?__________________.

NOTE: You should have noticed in the foregoing part of the job program that the frequency dial was set at zero(0) and that moving the sweep width control caused the frequency to change to the right and to the left by a certain amount of frequencies. Increasing the sweep width control in a CW direction further, caused the amount of frequencies on either side of zero(0) to increase. Rotating the VERN/MAN control increased the rate (speed) at which the frequencies were being swept.

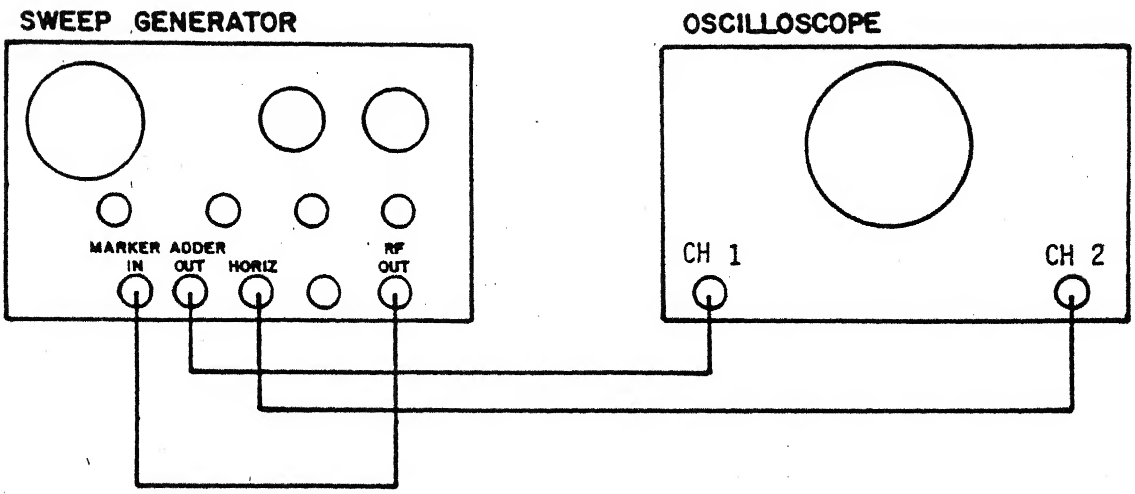



Figure 2

17. Connect the equipment as shown in Figure 2.

18. Set the controls on the sweep generator as follows:

    a. Turn the seven markers switches to the "off" position.

    b. Set the sweep width control to mid-range.

    c. Set the marker width control to "wide"

    d. Set sweep mode control to "1-50".

    e. Set VERN/MAN control to mid-range.

    f. Set the center frequency dial to "0".

    g. Set the marker size to mid-range. During the job program you may manipulate this control to your own individual eye comfort and to insure accuracy.

19. There should be a marker in the center of the scope. If the marker is not exactly centered on the scope and your sweep is centered, adjust your center frequency dial until the marker is centered on the scope. This is the zero (0) Hz marker. This will be used as a reference to locate the frequency that you want as the center frequency.

20. Set the center frequency dial to "5". The zero Hz marker should move to the left side of the scope.

21. On the sweep generator turn the third markers switch from the top to "on". This is the 10 MHz markers switch. The first 10 MHz marker should appear on the right side of the scope but not at the end of the sweep. The RF output is being swept from 0 HZ to 10 MHZ.

22. Adjust the center frequency dial until the 10 MHz marker appears 2 cm to the right of the vertical center line.

23. Turn "off" the 10 MHz markers switch. Turn "on" the second marker switch from the top on the sweep generator. These are the 1 MHz markers. Count them. There should be 9 markers between 0 Hz and the 10 MHz point.

24. From 0 Hz count the number of markers to the center of the scope.

    a. How many markers are there?________________.

25. From the point that you established as 10 MHz, count the markers to the center of the scope.

    a. How many markers are there?________________.

    b. What is the center frequency?________________.

    c. What is the center frequency dial on the sweep generator set to?________________.

    d. Do b and c above correspond?__________yes/no.

    e. Should they correspond?__________yes/no.

26. Set the center frequency dial to "0".

27. Rotate the sweep width control on the sweep generator CCW until the "0" Hz marker is on the left side of the scope and the center of the first 1 MHz marker appears on the right. Sweep length is now 1 MHz. The output is now being swept from 0 Hz to 1 MHz. Much can be determined from this. THINK.

    a. What is the center frequency?________________.

    b. What is the frequency response?________________.

c. What is the bandwidth?________________.

d. Turn off the 1 MHz markers.

28. Now let us go through the steps necessary to set the sweep generator to a specific center or resonant frequency. For this example let us choose 97.6 MHz.

a. Set the sweep width control to mid-range.

b. Set the center frequency dial to "0".

c. Position the 0 Hz marker at the center of the scope using the center frequency dial.

d. Turn on the 10 MHz marker switch. A 10 MHz marker should appear to the right and to the left of your center frequency 0 Hz marker. If it does not, turn the sweep width control CW until it does.

e. Turn the center frequency dial to 10. The first 10 MHz marker should appear at the center of the scope.

f. Turn the center frequency dial to 20. The second 10 MHz marker should appear at the center of the scope.

g. Turn the center frequency dial to 30. The third 10 MHz marker should appear at the center of the scope.

NOTE: The frequency dial may be slightly off from the actual display on the scope. Do not worry about it. The presentation on the oscilloscope is your true indication.

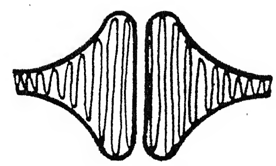
h. Turn the center frequency dial to 40. The fourth 10 MHz marker should appear at the center of the scope. You are now receiving 40 MHz from the sweep generator. Use the above procedure until you observe the 90 MHz marker at the center of the scope.

i. Turn off the 10 MHz markers and turn on the 1 MHz markers. The center marker is still 90 MHz.

j. Turn the center frequency dial and count 91, 92, 93, 94, 95, 96, 97. You now have 97 MHz centered on the oscilloscope which you are receiving from the sweep generator.

k. Turn off the 1 MHz markers. The top markers switch produces .1 MHz (100 kHz) markers. Turn it on.

L. Turn the sweep width control CCW until a signal appears looking like this. Center the display on the scope using the center frequency dial.



The very center of this waveform is 97 MHz.

m. Very gently turn the center frequency dial while counting 97.1, 97.2, 97.3, 97.4, 97.5, 97.6. If you do not do this gently you will have to go through the entire procedure again. The sweep generator is now producing 97.6 MHz.

n. Turn the sweep width control to mid-range.

NOTE: Although the frequency dial may be off, and it often is, even in test equipment in the field, the sweep generator is producing the correct frequency and the marker pips on the oscilloscope is your proof that it is.

NOTE: If you do not understand the above, select your own frequency in the MHz range and practice setting up the sweep generator to increase your proficiency before proceeding further in this job program. The following part of the job program requires the addition of an RF detector Model 8571 and the NIDA 205 Transceiver Trainer.

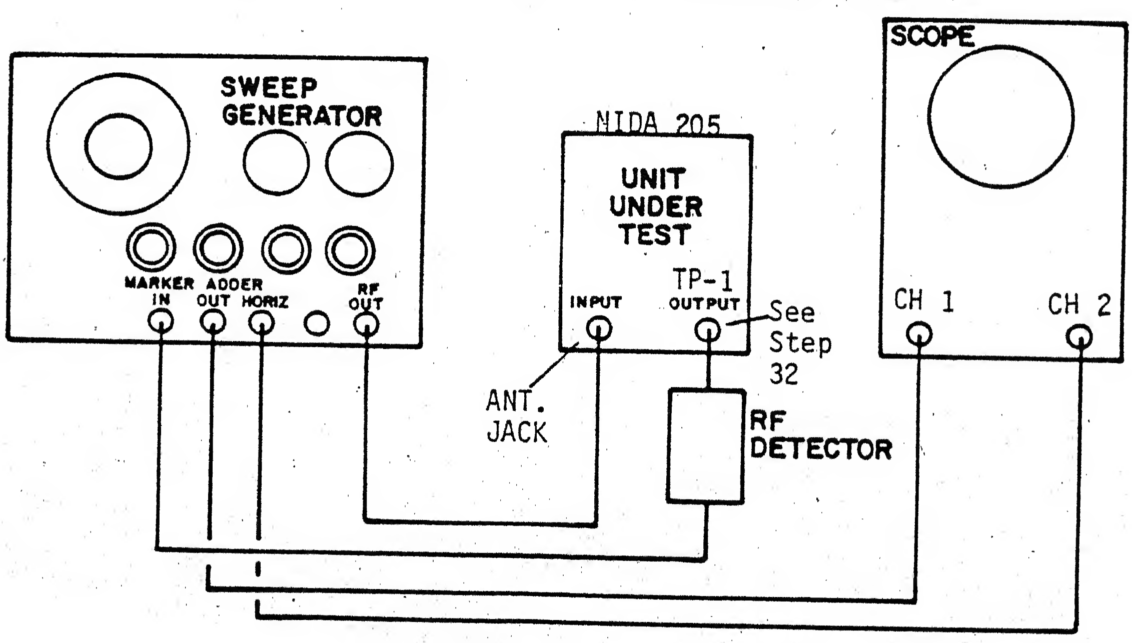



FIG. 3

29. Connect the equipment as shown in Figure 3.

30. Set the channel 1 Volts/Div control on the oscilloscope to 1.

31. Make the following adjustments on the NIDA 205 Transceiver. (Refer to schematic - end of this lesson)

    a. Plug in and energize the NIDA 205 Transceiver

    b. Using the fine frequency control, set up the NIDA 205 Transceiver to 97.6 MHz approximately.

32. Observing the NIDA 205 Transceiver, notice TP-1 to the left of J-2 on the chassis. This is the input tank to the RF amplifier. Insert the RF detector probe into this test point (TP-1).

33. Turn the fine frequency control on the NIDA 205 Transceiver until a frequency response curve appears on the scope. Center this response curve on the scope with the fine frequency control.

34. Turn all marker switches to the off position.

35. Measure the peak amplitude of the scope waveform_______________. Calculate what the amplitude should be at the .707 power points________.

36. Turn the RF level control fully CCW. This is exactly 3dB down from peak or the half power points. Calculate the amplitude of the waveform on the oscilloscope____________. Center frequency is __________ MHz.

    a. Does the amplitude in step 36 correspond to the amplitude in the second part of step 35?__________yes/no.

    b. Should they correspond?__________yes/no.

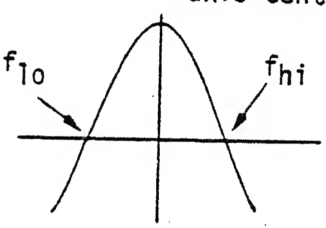
OTE: You have obtained some very important information. You found the resonant frequency of the input tank and the amplitude of this frequency at its Fo and also at the half power points. Now you are ready for bandwidth and frequency response measurements.

37. Set the vertical channel (Channel 1) on the oscilloscope to "DC".

38. Using the vertical position control on the oscilloscope, set the peak amplitude of the waveform exactly on the center horizontal reference line(X axis). This will be your reference point for the following measurements.

39. Turn the RF Level control fully CW.

40. Using the sweep frequency dial, center the response pattern on the scope. Your display should now look like the figure below.




The low and high frequency half-power points are now located at the point where the response curve crosses the center line.

41. Move the low frequency half-power point of the response curve over the intersection of the X and Y axis using the sweep frequency control.

42. Use the 10,1, and .1 MHz markers in conjunction with a CCW movement of the sweep width control to expand the sweep and measure the low freauency half-power point.

$f_{low}$ = ________________.

43. Repeat steps 41 and 42 for the high frequency half-power point.

$f_{high}$ = ________________.

44. Measure the frequency response and bandwidth of the RF amplifier input tank.

a. Frequency response equals ________ MHz to __________ MHz.

b. Bandwidth equals ______________ MHz.

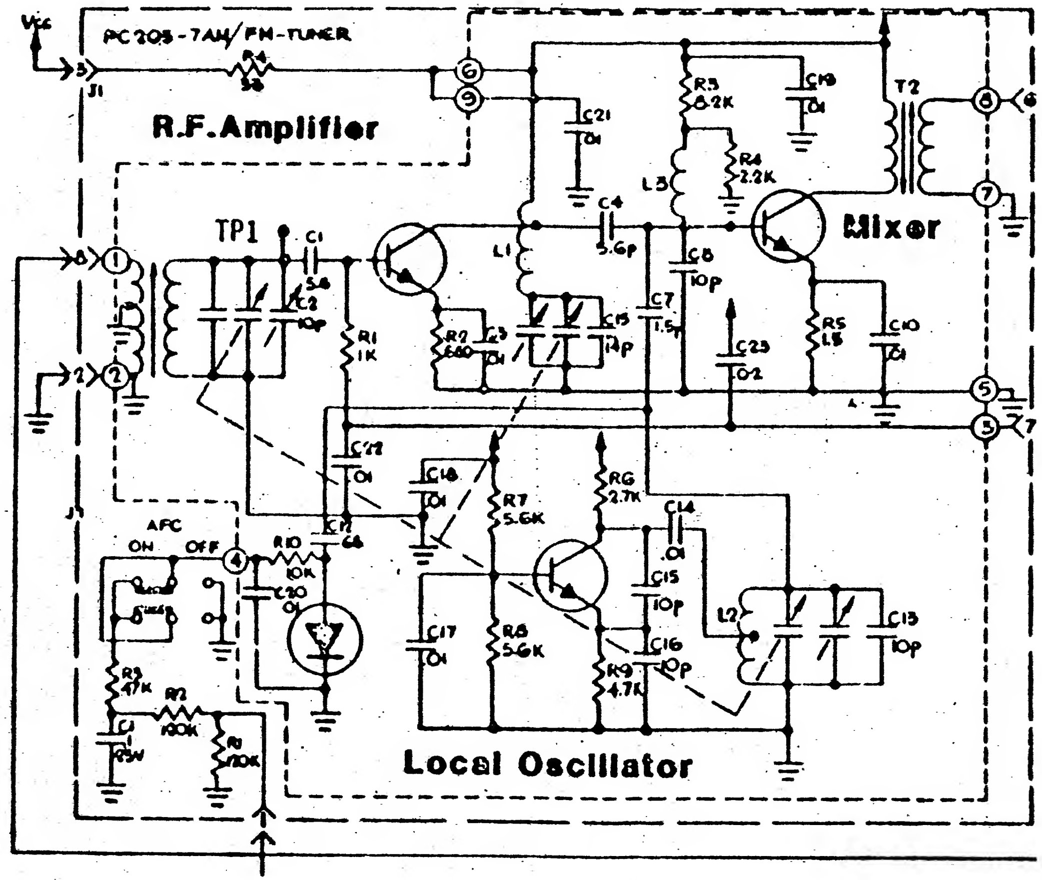
CHECK YOUR RESPONSES TO THIS JOB PROGRAM WITH THE ANSWER SHEET. IF YOUR RESPONSES AGREE WITH THE ANSWER SHEET, YOU MAY TAKE THE LESSON TEST. IF YOUR RESPONSES DO NOT AGREE OR IF YOU FEEL YOU HAVE FAILED TO UNDERSTAND ALL OR MOST OF THIS JOB PROGRAM, REVIEW THE PROCEDURES OF THIS JOB PROGRAM, ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS OR CONSULT WITH THE LEARNING CENTER INSTRUCTOR, UNTIL YOUR RESPONSES DO AGREE.

# Notes

# Notes

# Notes

# FREQUENCY CONVERTER




RF AMPLIFIER/FREQUENCY CONVERTER

ANSWER SHEET FOR

PROGRESS CHECK

LESSON 2

RF Amplifiers

| QUESTION No. | CORRECT ANSWER |
|---|---|
| 1. | c. |
| 2. | d. |
| 3. | d. |
| 4. | c. |
| 5. | b. |
| 6. | d. |
| 7. | 10 |
| 8. | b. |
| 9. | b. |
| 10. | B. |
| 11. | AB. |
| 12. | A. |
| 13. | d. |
| 14. | c. |
| 15. | a. |

ANSWER SHEET
FOR
JOB PROGRAM
LESSON 2

Sweep Generators and RF Amplifiers

6. a. No vertical line. disappeared.

8. a. No sweep voltage. disappeared.

12. a. Increased.

16. a. Increased.

24. a. 5

25. a. 5
    b. 5 MHz
    c. 6
    d. No
    e. Yes

27. a. 500 kHz
    b. 0 to 1 MHz
    c. 1 MHz

35. 0.6 V, 0.4 V

36. 0.4 V, 97.6 MHz
    a. Yes
    b. Yes

42. 95.8 MHz

43. 99.4 MHz

44. a. 95.8 to 99.4 MHz
    b. 3.6 MHz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